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Collimator for Limiting a Bundle of High-Energy Rays

Claims

1. Multiple leaf collimator (1) for limiting a bundle of high-energy rays (2) which emanates from a substantially point-like radiation source (3) to irradiate a treatment object (20), in particular for stereotactic conformation radiotherapy of tumors, wherein the collimator (1) contains a plurality of opposing collimator leaves (4,4`) made from radiation-absorbing material which can be brought into the optical path through drives such that its shape can be defined in an arbitrary manner, the front edges (5,5') of the collimator leaves (4,4`) always being parallel to the optical path, characterized in that the collimator leaves (4,4`) consist of a rear part (6,6`) which can be linearly displaced, and a front part (7,7`) linked thereto, wherein the front part (7,7`) of each collimator leaf (4,4`) is adjusted in accordance with the prevailing position of the corresponding rear part (6,6`) in such a way that the front edges (5,5`) are always parallel to the optical path, wherein the front part (7,7`) is linked to the rear part (6,6`) in such a fashion that there is no considerable gap in the volume of the radiation-absorbing material.

2. Collimator according to claim 1, characterized in that the drive means comprise a forced mechanical coupling

between all positions of the rear part (6,6') and of the front part (7,7') to align the front edges (5,5`).

3. Collimator according to claim 1 or 2, characterized in that the front parts (7,7`) are substantially semi-circular bodies (8,8`) which are securely disposed in corresponding recesses (9,9`) at the front end of the rear parts (6,6`) wherein the adjustment is a pivoting motion about an imaginary axis of rotation (36) lying in the center of the circle.

4. Collimator according to claim 3, characterized in that the height (10) of the rear part (6,6`) substantially corresponds to the diameter (11) of the semi-circular body (8,8`) and the front ends (12) of the rear part (6,6`) are set back to allow all required inclined positions of the front edges (5,5) of the collimator leaves (4,4`).

5. Collimator according to any one of the claims 1 through 4, characterized in that the cross-sections of the collimator leaves (4,4`) have an asymmetrical trapezoidal shape (13) such that their side surfaces (14) extend approximately parallel to the optical path, wherein inner surfaces (15) of the limitations (16) bordering the outer collimator leaves extend at an inclined angle to abut these outer collimator leaves (4,4`), without leaving gaps.

6. Collimator according to claim 5, characterized in that the front parts (7,7`) have sufficient lateral play such that they can be adjusted despite their trapezoidal shape (13).

7. Collimator according to any one of the claims 1 through 6, characterized in that the collimator leaves (4,4`) can be displaced beyond the center line (17) of the possible collimator opening (18).

8. Collimator according to any one of the claims 1 through 7, characterized in that each collimator leaf (4 or 4`) has an individual drive which can be individually controlled.

9. Collimator according to any one of the claims 1 through 8, characterized in that control of the collimator during operation thereof is effected via a computer which adjusts the contour and position of the collimator opening (18) to the radiation object (20) in the respective direction of radiation, wherein the computer obtains the data from a device for detecting the shape of the radiation object (20) and a control means examines the result of the adjustment.

10. Collimator according to any one of the claims 1 through 9, characterized in that the collimator leaves (4,4') are disposed in a collimator block (19) or collimator block halves which serve for positioning the collimator opening

(18) relative to the radiation object (20) and the radiation source (3).

11. Collimator according to claim 10, characterized in that the collimator block (19) is disposed on a gantry (41) wherein a relative motion between the collimator block (19) and a patient (46) is possible such that the patient (46) can be exposed to radiation from all sides, wherein the collimator opening (18) is adjusted to the shape of the radiation object (20).

12. Collimator according claim 2 or claim 2 and any one of the claims 3 through 11, characterized in that the forced coupling between the drive of the rear parts (6,6`) of the collimator leaves (4,4`) and the actuator for the front parts (7,7`) is effected via transmissions.

13. Collimator according to claim 12, characterized in that the transmissions for the collimator leaves (4,4`) are disposed alternately above, for one collimator leaf, (4,4`) and below, for the neighboring collimator leaf (4,4`).

14. Collimator according to claim 12 or 13, characterized in that the actuator for the front parts (7,7`) is designed such that it aligns same with respect to the radiation source (3) for an individual adjustment of the collimator leaves (4,4`) as well as for adjustment of all (4,4`) or part of the collimator leaves (4 or 4`).

15. Collimator according to any one of the claims 12 through 15, characterized in that the rear part (6,6`) has a collimator toothed rack (21) into which a driving toothed gear (23) engages.

16. Collimator according to claim 15, characterized in that the collimator toothed rack (21) associated with the rear part (6,6`) is designed as gearing of a longitudinal edge (37).

17. Collimator according to claim 16, characterized in that in the region of the gearing of the longitudinal edge (37), the adjacent rear part (6,6) is vertically displaced in the collimator block (19) such that, above the gearing, a guiding element (25) which is connected to the side of the collimator block (19) engages in a guiding groove (26) of the rear part (6,6`).

18. Collimator according to any one of the claims 15 through 17, characterized in that a front edge toothed rack (22) is pivoted on the front part (7,7`) outside of its axis of rotation (36) into which a toothed wheel (23 or 24) engages, wherein an adjustment path is effected which differs from that of the rear part (6,6`) such that the front edge (5,5`) is correspondingly aligned.

19. Collimator according to claim 18, characterized in that the collimator toothed rack (21) and the front edge

toothed rack (22) are disposed on a longitudinal edge (37) of the rear part (6,6`) and have different subdivisions (52,53,54) for obtaining the different adjustment paths, wherein a toothed wheel (23 or 24) engages both toothed racks (21,22) with the subdivision difference lying within the tolerance limits of the gearing.

20. Collimator according to claim 19, characterized in that the subdivision (53) of the front edge toothed rack (22) disposed below a collimator (4,4`) is larger than the subdivision (52) of the collimator toothed rack (21).

21. Collimator according to claim 19 or 20, characterized in that the subdivision (54) of the front edge toothed rack (22) for a gearing disposed above the collimator (4,4`) is smaller than the subdivision (52) of the collimator toothed rack (21).

22. Collimator according to any one of the claims 18 through 21, characterized in that the toothed wheels (23 or 24) are disposed in a base frame (58).

23. Collimator according to any one of the claims 18 through 22, characterized in that the toothed wheels (24) simultaneously serve as driving toothed wheels (23) and are disposed in the collimator block (19).

24. Collimator according to claim 14 with any one of the claims 19 through 23, characterized in that the driving toothed wheels (23) which engage in the driving toothed racks (55,21 or 22) are disposed in one displaceable collimator block (19) or two displaceable collimator block halves, and further toothed wheels (24) which engage the collimator toothed racks (21) and the front edge toothed racks (22) are disposed on a base frame on which the entire collimator block (19) or the collimator block halves can be displaced - each for one part of the collimator leaves (4 or 4`).

25. Collimator according to any one of the claims 14 through 17, characterized by link members for adjusting the front parts (7,7`).

26. Collimator according to claim 25 and 15, characterized in that connecting link guides (27) are rigidly connected to the bearing of the driving toothed wheels (23) and link guide sliders (28) cooperate with the front parts (7,7`)

27. Collimator according to claim 25 and 15, characterized in that the connecting link guides (27) are rigidly connected to a base frame (58), and displaceable collimator block halves are rigidly connected to the bearings of the driving toothed wheels (23) - each for one part of the collimator leaves (4 or 4`).

28. Collimator according to claim 26 or 27, characterized in that the slider (28) is mounted to a cable control (29) which is guided towards the front part (7,7`) and which is mounted at one end (30) above its imaginary axis of rotation (36) and at the other end (31) below the imaginary axis of rotation (36) of the front part (7,7`).

29. Collimator according to claim 26 or 27, characterized in that the slider (28) is mounted to a rear end (34) of a double-armed lever (32), wherein the lever (32) is disposed with its rotation axle (33) on the rear part (6,6`) and with its front end (35) in the rear region of the front part (7,7`).

30. Collimator according to any one of the claims 1 through 29, characterized in that a guide (38) is provided on at least one longitudinal edge (37) of a rear part (6,6`).

31. Collimator according to claim 30, characterized in that the guide (38) consists of a groove (39) in the longitudinal edge (37) in which a guiding element (40) slides.

32. Collimator according to any one of the claims 1 through 31, characterized in that the collimator leaves (4,4`) serve as compensating means for generating different radiation intensities via temporary insertion into the collimator opening (18) during irradiation.

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